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Get Wet

September 2019

ATLS 4151-001

Bubble Hop

With free reign on choosing a fluid dynamic phenomenon to capture, I decided to do something I knew I could create at home, while also learning a new phenomenon. I created this image to visualize the Leidenfrost Effect. To my limited fluid dynamic knowledge; the Leidenfrost Effect is a phenomenon where when a liquid is extremely close to a surface that is far hotter than that liquid's boiling point, the bottom part of the liquid heats up so fast that it creates an insulating layer that stops the rest of the liquid from boiling, making the liquid hover above the surface, never actually touching it, and skid off quickly. I wanted to capture water droplets floating above a surface at an extremely high shutter speed to show these droplets seemingly levitating in midair. I wouldn't have been able to capture these images without the help of my roommate, Kaitlin Lee, who managed the water flow and lighting of the scene.

To simulate the Leidenfrost effect, you first need an extremely hot surface. I used a simple flatbed hotplate, turned onto the highest setting. You then need a liquid: I used tap water, with no additives (beyond what may be already contaminating the water because of the tap). I made sure that the hot plate was far hotter than 100 C (water's boiling point), by dropping a few test droplets of water onto the plate. When the plate was around 100 C, the water sizzled and evaporated quickly. I waited for the plate to get hotter and dropped some more water on it. When the plate was hot enough, the droplets skidded off the plate quickly, and moved in various sporadic directions. Once the plate was hot enough, I set up my studio. I put my camping tent footprint (a black material with a little bit of reflectivity), underneath and behind the hot plate. I then took every lamp I could find in the house, took off their lamp shades, and set them up extremely close to the hot plate. I even had to have Kait hold one of the lamps extremely close to the hot plate for the scene to be bright enough for the camera to pick anything up. All the lamps I used were around 70-watt bulbs, just your average house lights. These were all warm, yellow-orange-white-ish tinted

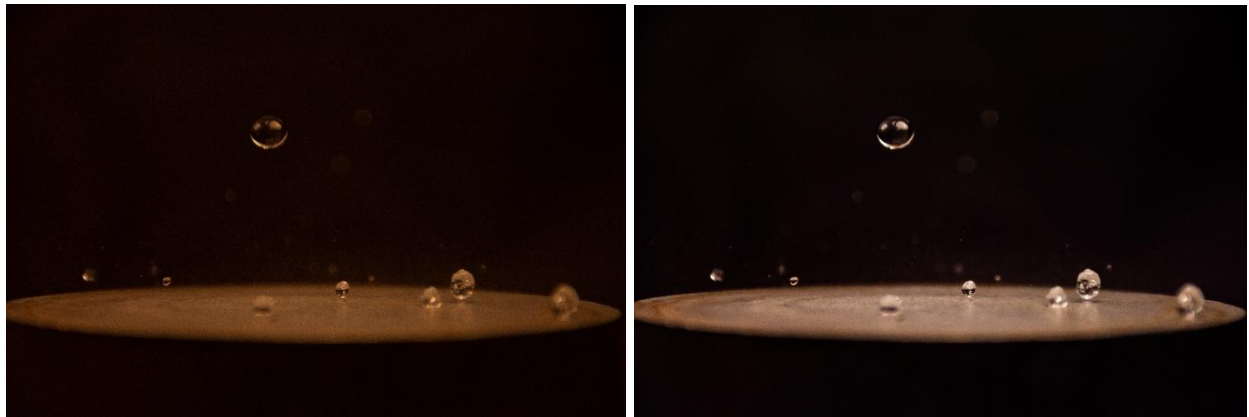
lights. The hardest part of this experiment was getting the lighting correct.



My visualization technique was simple. Like I said before, I just used tap water with no additives. The lighting was the most important part of the visualization; I needed the scene to be bright enough and for the lights to be placed strategically in spots that lit up the droplets in the most beautiful way. Since I wanted to capture the droplets hovering in place without movement, I had to set the camera at an extremely high shutter speed because the droplets skidded off the surface extremely fast. Since the shutter speed had to be above $1/1000$ to freeze this movement, it was hard for the camera to pick up the lights, despite the scene being very well lit. I zoomed in as

far as I could with my kit lens: a 18.0-140.0mm with f/3.5 lens. To help the camera pick up more light, I opened my f-stop to the largest setting it could open when the lens was fully zoomed in: f/5.6. My focal range ended up being very small because of this zoom and the f-stop, but I wanted to capture only the droplets, as close as I could and get enough light for the camera to pick up, so I decided to deal with this small focal length for the picture to be as I envisioned. I raised my ISO to one of the highest settings to compensate for this lighting issue as well. I tested multiple different camera settings in this shoot to see what setting mix had the best effect. I tested shutter speeds from 1/1000 to 1/3200. I always kept the same f-stop, because I didn't have enough light to make it any higher. I tested ISOs between 800 and 4000. I was worried the pictures would come out too noisy, but I decided it was better to capture anything at all and try to denoise in post-processing, then not be able to see the "frozen" droplets at all. I then used a household child's medicine syringe, filled it with water, and had Kait drop the water on the plate as she was holding one of the naked bulbs centimeters above the droplets, just out of the camera's view. The rest of the bulbs were placed less than a foot from the hot plate, surrounding it on all sides. I had 8 bulbs total contributing light.

The size of the field of view was just as wide as the hotplate. I lined up the camera's frame to be exactly this width to capture as many droplets as I could as they skidded all over the plate in a matter of milliseconds. This width was probably about 6 inches wide. To have the camera frame the hotplate's width, the camera was about 6 inches from the hot plate. I used a Nikon D7200 to take these pictures. The final image had an exposure of 1/2000 sec, f/ 5.6, a focal length of 140 mm and an ISO of 1000. The original image's width and height was: 6000 x 4000 px while the cropped image ended up being 5961 x 4000 px. The reason I cropped the width was to make sure the hot plate was centered in the frame and cropped evenly on both sides. The original image was shifted a little more to the right than I had intended. In post processing, I did a lot of color correction. Since the bulbs I used were all warm bulbs, the image ended up coming out extremely orange. I had to rebalance the colors to get the image to look like it did with the naked eye. I did this by adding blues and greens to the image. I also enhanced the contrast and exposure, slightly increased the highlights and whites while slightly decreasing the shadows and blacks (these all contributed to an increased contrast look). I also added some clarity, dehazing, vibrance and saturation. I also ran some noise reduction and smoothed out the noise luminance in the image to put more focus and clarity on the water droplets and get rid of any grain/noise.



I thought I captured exactly what I intended: the water droplets seemingly levitating in midair. I thought the image was beautiful, but I don't think you would be able to look at this image and know exactly what was going on physically. It needs some explanation to describe what the water droplets are doing and why. The one thing I would change about this image to help the viewer understand what was going on more would be to have more droplets hovering above the surface. This would really visualize the Leidenfrost Effect's force on water and would make it clear the image was not just me happening to capture a few droplets before they smashed on the surface of the plate. However, overall, I was very happy with how my image turned out.